REMARKS

The present reply and amendment is filed in response to the Office Action mailed April 6, 2005, allowing claims 12-24. The Applicants respectfully request reconsideration of claims 1-11. The amendments above, and remarks that follow, address points raised in the Office Action, and, thereby, place this application in condition for allowance.

Claims 1-24 were pending in this Application. By this Amendment, claims 25 and 26 were added to the Application. Accordingly, claims 1-26 are now pending in this Application. Claims 1, 7, and 12 are independent claims and the remaining claims are dependent claims. No new matter has been added by the proposed amendments.

Claim Objections:

The disclosure has been objected to because of an informality relating to the claims. The Examiner states that "the present US Patent Office practice is to insist that each claim must be the object of a sentence starting with "I (or we) claim," "The invention claimed is" (or the equivalent)" and that appropriate correction is required. However, such language was present in the application as originally filed. The Applicants direct the Examiner's attention to page 16, lines 14-15 of the application where the language "In view of these and other modifications, what we claim is:" is included. As such, the Applicants believe that no correction is necessary and the objection should be withdrawn.

Drawing Objections:

The drawings were objected to as failing to comply with 37 CFR §1.84(p)(5). Figure 2 was objected to as not showing element 22 as specified in the specification on page 8, line 28. Figure 2 has been amended to include reference numeral 22 directed to the source. The amendment does not add new matter to the application. A Notice to the Official Draftsperson is also being submitted concurrent with this Amendment.

Figure 3 was objected based upon the Examiner's assertion that the figure should include a legend such as "Prior Art" because only that which is old is illustrated. The Applicants respectfully traverse this objection. In the present case, the steps illustrated in Figure 3 are

shown as part of the Applicant's embodiment. If Figure 3 is marked as prior art, it is feared that such labeling would lead to confusion of those who read Figure 3 in conjunction with the associated description in the specification. The Applicant directs the Examiner to page 10, lines 712 of the specification as an example. Figure 3, therefore, has not been amended to include "Prior Art" as a legend.

Specification Objections:

The disclosure was objected to because the specification is not consistent with the reference numerals in Figure 2. The specification has been amended to correct the deficiency. No new mater has been added to the application by the amendment.

Allowed Claims:

Claims 12-24 have been allowed.

Claim Rejections under 35 U.S.C. §103:

Claims 1, 2, and 7 were rejected under 35 U.S.C. §103 as unpatentable over U.S. Patent No. 6,289,235 to Webber et al. Claims 3 and 8 were rejected under 35 U.S.C. §103 as unpatentable over Webber further in view of a reference entitled "Design and Implementation of an Application Programming Interface for Volume Rendering" to Selldin. Claims 4 and 9 were rejected under 35 U.S.C. §103 as unpatentable over Webber further in view of Selldin and further in view of a reference entitled "A Programmabe Graphics Chip" to Jain. Claims 5, 6, 10, and 11 were rejected under 35 U.S.C. §103 as unpatentable over Webber further in view of Selldin and further in view of a reference entitled "SMASH: A Next Generation API for Programmable Graphics Accelerators" to McCool. The Applicants respectfully disagree with these contentions and asserts that the present claims are not anticipated by any disclosure in the Webber, Selldin, Jain, and McCool references, either alone or in combination.

The Applicants' independent claim 1 recites an improved method of back-projecting a two-dimensional (2D) representation ("first 2D representation") to a generate three-dimensional (3D) representation. As recited in claim 1, in reconstruction imaging, a volume is reconstructed from a series of measured projection images, each generated by projection of a radiation source

positioned at a respective focus through the volume to a detector at which the respective measured projection image is acquired ("detector plane"). For each of one or more slices of the 3D representation parallel to the detector plane and for each distinct focus at which a said measured projection images is generated, the method includes warping the first 2D representation to generate a second 2D representation, and incrementing values of each of one or more voxels of the respective slice by an amount that is a function of a value of a correspondingly indexed pixel of the second 2D representation. The warping step includes applying to the first 2D representation a selected linear mapping, where that selected linear mapping would map, in order to match dimensions of the respective slice within the 3D representation, a region defined by projection, at the respective focus, of corners of that slice onto the detector plane

The Applicants' independent claim 7 recites an improved method of forward-projecting a three-dimensional (3D) representation ("first 3D representation") to generate a two-dimensional (2D) representation where the 2D representation is in the detector plane. As recited in claim 7, in reconstruction imaging, a volume is reconstructed from one or more projection images, each generated by projection of a radiation source positioned at a respective focus through the volume to a plane at which the respective projection image is acquired ("detector plane"). For each distinct focus at which a projection image is generated and for each of one or more slices in the first 3D representation parallel to the detector plane, warping the respective slice of the first 3D representation to generate a respective slice of a second 3D representation and incrementing values of each of one or more pixels of the 2D representation by an amount that is a function of a value of a correspondingly indexed pixel of the respective slice of the second 3D representation. The warping step includes applying to the respective slice of the first 3D representation a selected linear mapping, where that selected linear mapping would map a region defined by projection of corners of the respective projection image onto the respective slice for the respective focus to match dimensions of the projection image in the detector plane.

Webber relates to a method for creating or synthesizing a slice image through an object from a series of two-dimensional projected images of the object. Initially, a fiducial reference is affixed directly to the selected object. The selected object and fiducial reference are exposed to radiation from any desired projection geometry and a two-dimensional projected image is

recorded. The projected image contains an object image of the selected object and reference images for each of the reference markers of the fiducial reference. If additional projected images are desired, the system geometry is altered by varying the relative positions of the radiation source, the selected object and the fiducial reference, and the recording medium and the additional projected images are recorded. Once all of the images have been obtained, a slice position is selected where the slice position corresponds to the position at which the image slice is to be generated through the object. Each projected image is then projectively warped onto a virtual projection plane. The warping procedure produces a virtual image corresponding to each of the actual projected images. Each virtual image is identical to the image which would have been produced had the projection plane been positioned at the virtual projection plane with the projection geometry for the radiation source, the selected object, and the fiducial reference of the corresponding actual projected image.

While independent claim 1 was rejected under 35 U.S.C. §103(a) as being unpatentable over Webber, the Examiner has not established a *prima facie* case of obviousness with respect to claim 1 because Webber does not teach or suggest all of the claim limitations in the claim. For example, the Applicants claim, during of back-projecting a two-dimensional representation, "warping the first 2D representation to generate a second 2D representation, the warping step including applying to the first 2D representation a selected linear mapping, where that selected linear mapping would map, in order to match dimensions of the respective slice within the 3D representation, a region defined by projection, at the respective focus, of corners of that slice onto the detector plane." In other words, as related in the Applicants' claim 1, when warping the first 2D representation to generate the second 2D representation, the linear mapping maps corners of the first 2D representation of the image of the detector plane to specific locations or corners within the 3D reconstruction in order to match dimensions of the respective slice within the 3D representation. In Webber, by contrast, after obtaining a series of images, each projected image is then projectively warped onto a virtual projection plane to produce a virtual image corresponding to each of the projected images. In Webber, there is no specific mapping of corners of a slice to corners within a 3D representation "in order to match dimensions of the respective slice within the 3D representation." Webber merely describes warping projected images to a virtual projection plane with no mention of specific mapping of corners of the image to corners of the 3D image, as claimed by the Applicants.

Also, the Examiner has not established a *prima facie* case of obviousness with respect to claim 7 because Webber does not teach or suggest all of the claim limitations in the claim. For example, the Applicants claim front-projecting a first 3D representation where the first 3D representation includes radiation absorption estimates for a volume. The Applicants further claim warping the respective slice of the first 3D representation to generate a respective slice of a second 3D representation, the warping step including applying to the respective slice of the first 3D representation a selected linear mapping. In Webber, by contrast, a fiducial reference is affixed directly to a selected object and the selected object and fiducial reference are exposed to radiation from any desired projection geometry. A two-dimensional projected image is recorded and then projectively warped onto a virtual projection plane. While Webber describes obtaining a projected image by exposing a physical object to a radiation source and warping the image, Webber does not teach or suggest claim front-projecting a 3D representation of a volume and warping each slice of the 3D representation to generate a 2D representation.

Claims 1 and 7 are, therefore, patentable over Webber for at least the above reasons. Further, claims 2-6, which depend from claim 1, and claims 8-11, which depend from claim 7 each contain all the features and limitations of claim 1 and are allowable for the same, and other, reasons.

Furthermore, none of the Selldin, Jain, and McCool references cited by the Examiner teaches or suggests all of the limitations of the Applicants' independent claims 1 and 7. Selldin relates to design and implementation of an application programming interface (API) to be used for developing volume-rendering applications. Jaine describes a programmable graphics chip from NVIDIA having a pixel shading fuctionality that combines color, lighting, and texture data to select pixel colors for an application. McCool describes a programmable shader API. None of the references, alone or in combination with Webber, teach or suggest all of the elements of the Applicants' claims 1 and 7 as described above with respect to Webber.

Additional Claims:

The Applicants have added dependent claims 25 and 26 to the Application. In claim 25 the Applicants claim, during of back-projecting a two-dimensional representation, "warping the first 2D representation to generate a second 2D representation, the first 2D representation formed as intensity differences between the said measured projection images and a projection of an

estimate of the volume." In Webber, after obtaining a series of images, each projected image is then projectively warped onto a virtual projection plane to produce a virtual image corresponding to each of the projected images. Webber does not teach or suggest back projecting a 2D representation formed as intensity differences between measured projection images and a projection of an estimate of the volume, as claimed by the Applicants and claim 25 should be allowed.

New claim 26 relates to reconstructing a volume from a series of measured projection images, each generated by projection of the radiation source positioned at a respective focus through the volume to a fixed detector at which the respective measured projection image is acquired (e.g., a fixed detector plane). In Webber, as described above, to obtain multiple projected images of an object, the system geometry is altered by varying the relative positions of the radiation source, the selected object and the fiducial reference, and the recording medium and the additional projected images are recorded. Webber teaches of a positionable recording medium and does not teach or suggest the use of a fixed detector as claimed by the Applicant.

Conclusion

In view of the above, Applicant respectfully submits that the claimed invention is patentable. Applicant therefore kindly requests consideration of all claims in light of the above remarks and allowance thereof.

Applicants hereby petition for any extension of time which is required to maintain the pendency of this case. If there is a fee occasioned by this response, including an extension fee, that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 141449.

The Examiner is also kindly requested to contact the undersigned if such would expedite examination and allowance of the application.

Respectfully submitted,

NUTTER, McCLENNEN & FISH, LLP

Date: August 8, 2005

Jeffrey J. Duquette
Reg. No. 45,487
Attorney for Applicants

World Trade Center West
155 Seaport Boulevard
Boston, MA 02120-2604
Tel: (617)439-2680
Fax: (617)310-9680

1443367.1